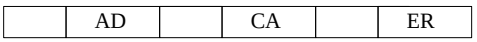
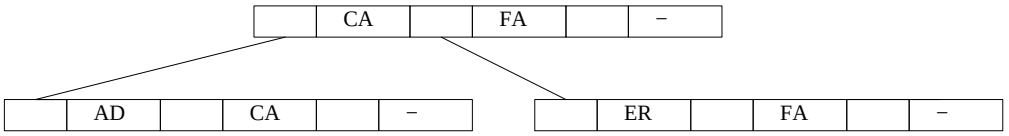
Question 1 - A

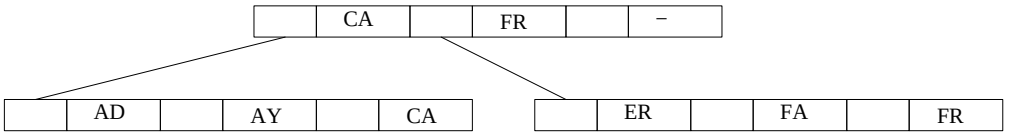
Insert AD, CA, ER:



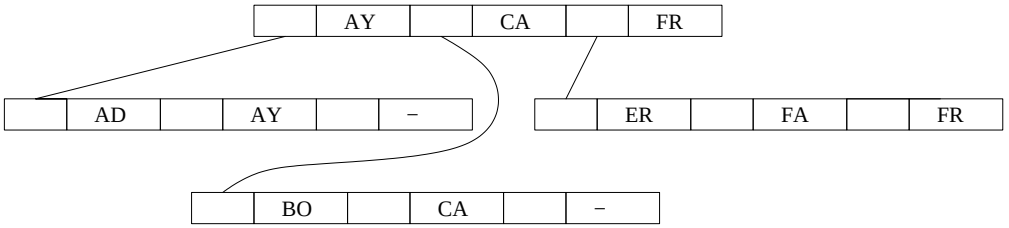
Insert FA:



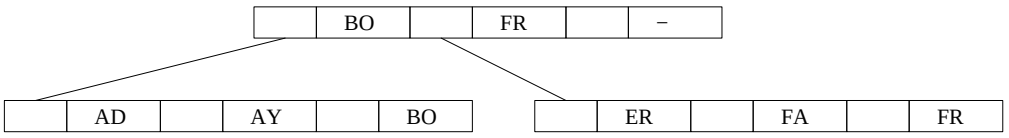
Insert FR, AY:



Insert BO:

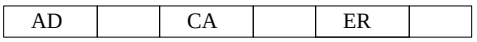


Delete CA (use merging):

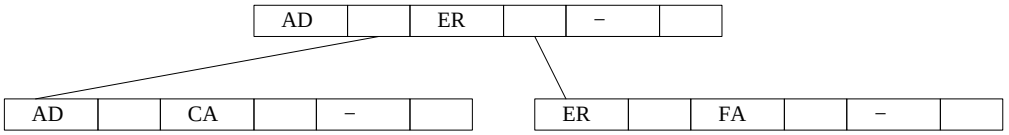


Question 1 - B

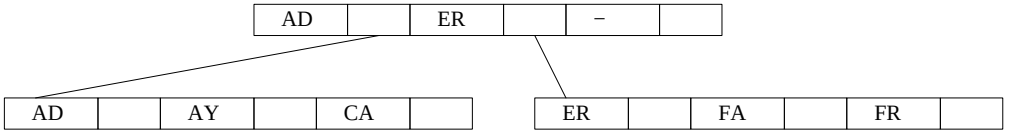
Insert AD, CA, ER:



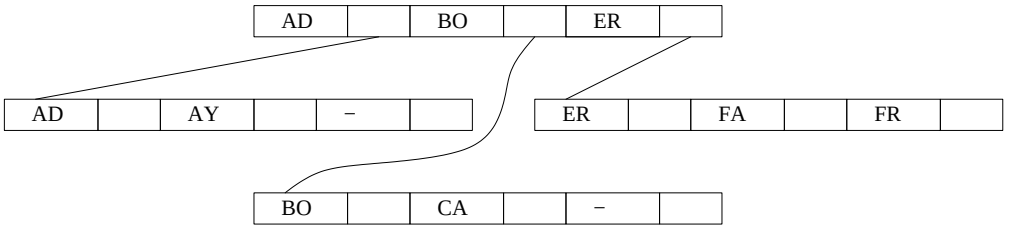
Insert FA:



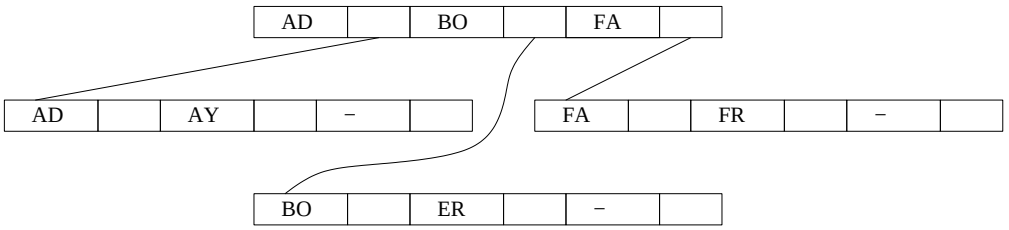
Insert FR, AY:



Insert BO:

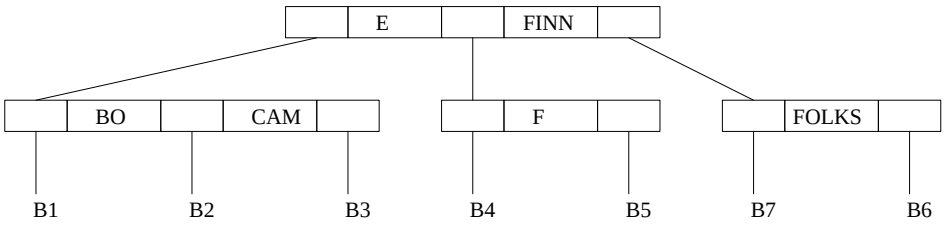


Delete CA (use redistribution):



Question 2

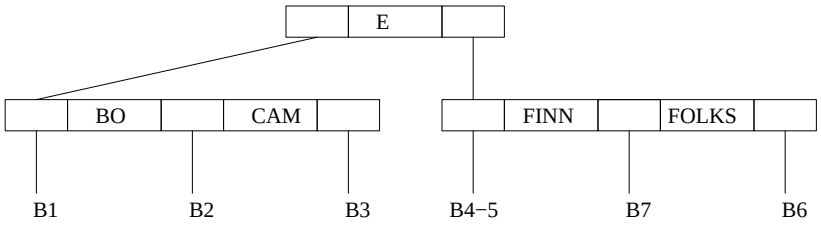
A) As follows:



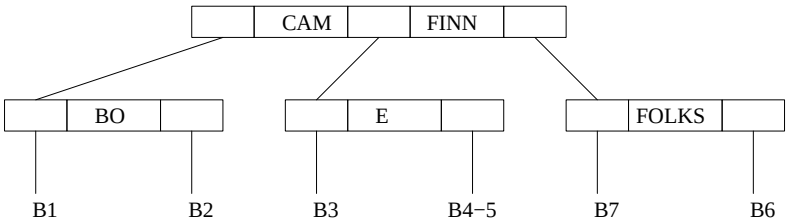
Note: If "invisible" keys are shown, they are: A, A, E, FINN (root, left child, middle child, right child)

B) There are two possible solutions:

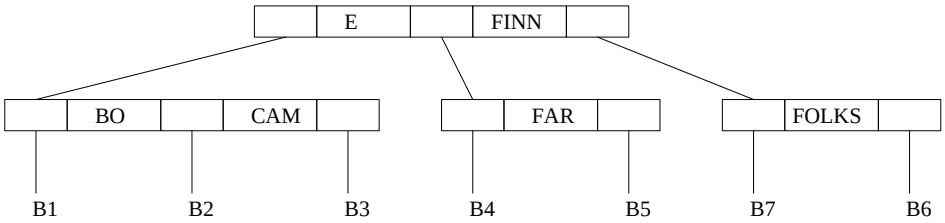
B1) Merging



B2) Redistribution



C) As follows:



Question 3

$N = 10,000 \qquad r = 8,000$

Let $p(x)$ be the probability that an address in the table "receives" exactly x records. Using the formula

$$p(x) \cong \frac{(r/N)^x e^{-r/N}}{x!}$$

we get (numbers rounded to 4 places after the decimal)

$p(0)$	$p(1)$	$p(2)$	$p(3)$	$p(4)$	$p(5)$	$p(6)$	$p(7)$
0.4493	0.3595	0.1438	0.0383	0.0077	0.0012	0.0002	0.0000

A) Packing density $= \frac{r}{N} = \frac{8,000}{10,000} = 0.8 = 80\%$

B) $N \times p(0) = 4,493$

C) $N \times p(1) = 3,595$

D) $N \times (p(2) + p(3) + p(4) + \ldots)$
$= N \times (1 - p(0) - p(1))$
$= 10,000 - 0.1912$
$= 1,912$

E) Solution 1:
$N \times (p(2) + 2p(3) + 3p(4) + 4p(5) + \ldots)$
$\cong 10,000(0.1438 + 2 \times 0.0383 + 3 \times 0.0077 + 4 \times 0.0012 + 5 \times 0.0002)$
$= 2,493$

Solution 2 (Alternative formula):
$r - N(p(1) + p(2) + p(3) + \ldots)$
$= r - N(1 - p(0))$
$= 8,000 - 10,000(0.5507)$
$= 2,493$

F)

$$\frac{number\ of\ overflow\ records}{number\ of\ records} = \frac{2,493}{8,000} \cong 0.31 = 31\%$$

Question 4

A) Hash('PAL') $= (2 \times 80 + 65 + 3 \times 76)$ *mod* 6
$= 453$ *mod* $6 = 3$

Hash('LAP') $= (2 \times 76 + 65 + 3 \times 80)$ *mod* 6
$= 457$ *mod* $6 = 1$

B) As follows:

0	SET
1	LAV
2	PET
3	VAL
4	PAT
5	MAP

C) As follows:

Key	Home Address	Search Length
VAL	3	1
LAV	1	1
MAP	5	1
PAT	3	2
PET	1	2
SET	1	6

Average search length $= \frac{1+1+1+2+2+6}{6} = \frac{13}{6} \cong 2.17$

Question 5

A) As follows:

0	CAT	-1
1	PET	2
2	SET	-1
3	PAT	4
4	SAT	0
5	MAP	-1

B) As follows:

Key	**Home Address**	**Search Length**
MAP	5	1
PAT	3	1
PET	1	1
SET	1	2
SAT	3	2
CAT	3	3

Average search length $= \frac{1+1+1+2+2+3}{6} = \frac{10}{6} \cong 1.67$

C) As follows:

Hashed File

0		
1	PET	0
2		
3	PAT	1
4		
5	MAP	-1

Overflow Area

0	SET	-1
1	SAT	2
2	CAT	-1